

HABITATS OF THE ACEC

BARRIER BEACH

A barrier beach is a narrow strip of beach and dune separated from the mainland by a wetland or water body. Beaches are formed when waves transport and deposit sand on the shore; dunes are defined as hills or ridges of sand, pebble, and/or cobble deposited by wind and wave action and are often covered by beachgrass. All dunes extending from the beach to the marsh or bay are part of the barrier beach. Together the beach, dunes, tidal flats, and associated water bodies comprise the dynamic barrier beach system. Forces of nature constantly reconfigure these areas; sand is moved by storms, currents, waves, and wind. The strength of the barrier beach system lies in its dynamic nature and its ability to move and reshape. While these areas provide storm protection for property and natural resources land-ward of the barrier, they also serve as habitat for a variety of plant and animal species. Equally important are the recreational and aesthetic qualities provided by barrier beaches (CZM 1994).

Both Plum Island and Crane Beach are some of the few natural barrier beach/dune and salt marsh complexes left in the Northeast. Longshore currents have historically extended Plum Island south while rising sea levels, combined with wind and wave action have displaced the island westward to the point where its northern end is separated from the mainland only by the narrow Plum Island River. The Castle Neck Sand Spit (commonly known as Crane Beach) stretches for more than four miles along Ipswich Bay and consists of fine sand derived from deposits of late glacial marine clays. These deposits underlie the offshore, salt marshes, and coastal lowlands. Sands from these deposits are carried by storm and wave action toward shore, forming the beaches. Both Plum Island and Crane Beach are home for many wildlife species, including the endangered piping plover and least tern.

ESTUARINE WATERS

Located within the ACEC boundary are Plum Island Sound and Essex Bay, which are some of the most undisturbed estuarine habitats in the Northeastern United States. These bodies of water serve as nurseries for fish and shellfish and provide habitat and food for birds and other wildlife. Open waters of these estuaries change with the seasons. In the spring, large amounts of fresh water runoff from melting snow and spring rains dilute the salt content. During dry weather in the summer, inputs of fresh surface water are reduced and cause estuarine salinity to increase close to levels of offshore waters (Buchsbaum et al. 1996).

Plum Island Sound

Plum Island Sound is known for its extensive salt marsh and tidal flats, rich shellfish beds, and abundant fish and wildlife. The Sound is a relatively narrow body of water, oriented primarily in a north-south direction from its mouth at Ipswich Bay to its northern and western extensions in the Parker and Plum Island rivers (Figure 4). The Sound is an estuary encompassing 4,470 acres over an 8 mile reach (Table 2). The salinities of the tidal waters range from 22.3 to 30.8 ppt (Buchsbaum and Purinton 2000). The primary sources of fresh water are the Ipswich and Parker rivers that drain into the Sound. Smaller rivers include the Mill and Little Rivers which run into the Parker River, Rowley-Egypt River, Plum Island River, Mud Creek, and Eagle Hill River. The latter three are completely tidal throughout their length.

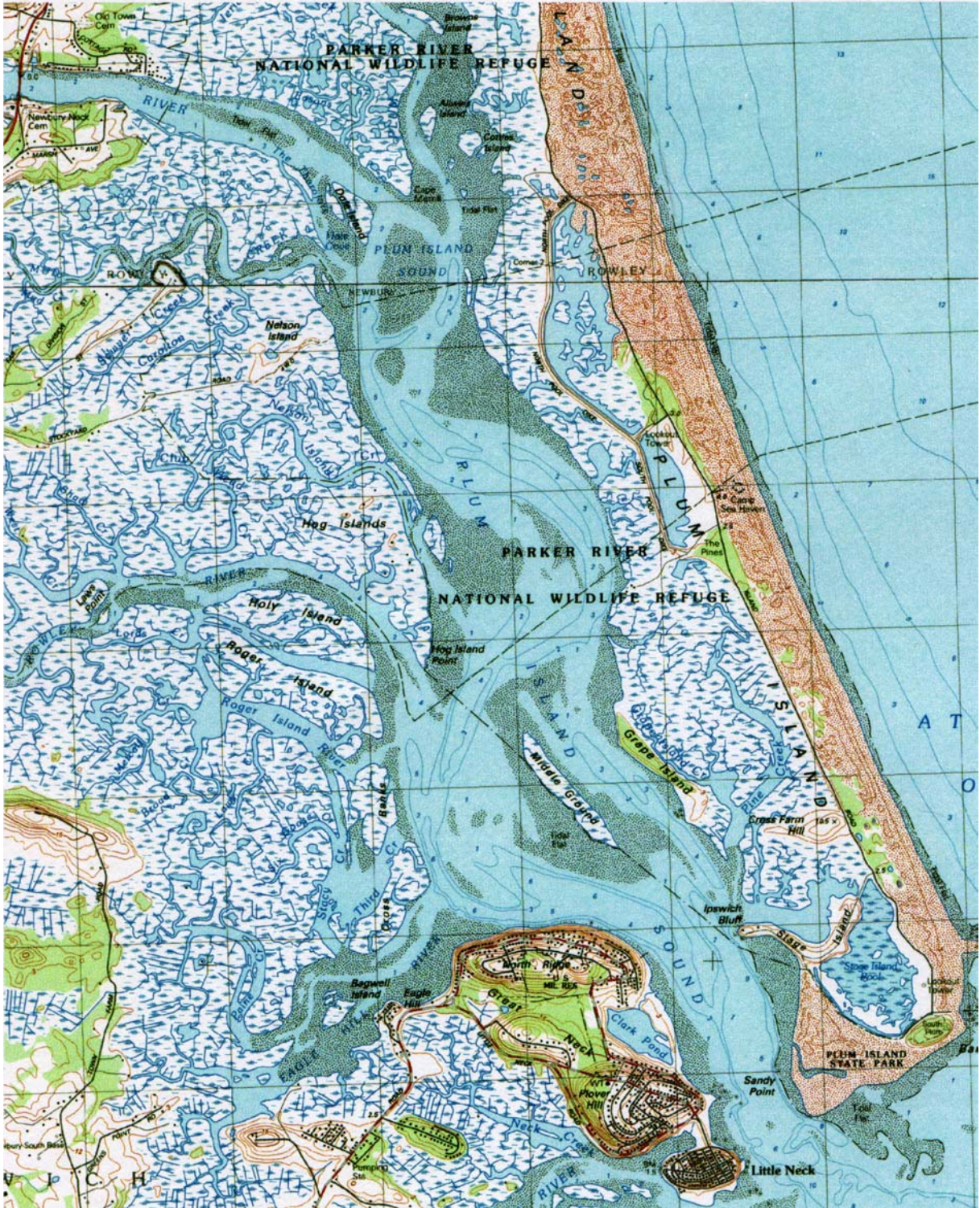


Figure 4. USGS Map of Plum Island Sound

Table 2. Morphometric measurements of Plum Island Sound (Buchsbaum and Purinton 2000)	
Description	Units
Maximum Length	8.17 miles
Maximum Width	1.86 miles (Mean High Water) [MHW]
Maximum Depth	50.0 feet (MHW)
Mean Depth	9.9 feet (MHW)
Total Surface Area	4,470 acres
Length of Shoreline	162.2 miles (MHW)
Volume	1,933,236,360 cubic feet (MHW)
Mean Tidal Amplitude	8.6 feet (Ipswich River mouth)
Salt Marsh Area	8,140 acres

Essex Bay

Essex Bay is bordered on the north and west by the town of Ipswich, south and west by Essex, and east by Gloucester (Figure 5). This estuary encompasses 1,909 acres of tidal waters (Table 3) and is composed of the bay proper and the following rivers and tributaries: Castle Neck River, Essex River, Ebben Creek, Farm Creek, Lanes Creek, Lufkin Creek, Walker Creek, and Soginese Creek. The Essex River, which is the main tributary, enters the Bay at Conomo Point and provides a constant flow of fresh water. Bay salinity ranges between 20.5 to 32.0 ppt (Chesmore et al. 1973). Approximately 70 percent of the total surface area of the Bay is intertidal (Roach 1992).

Table 3. Morphometric measurements of Essex Bay (Chesmore et al. 1973)	
Description	Units
Maximum Length	3.59 miles
Maximum Width	2.92 miles (MHW)
Maximum Depth	47.0 feet (MHW)
Mean Depth	7.3 feet (MHW)
Total Surface Area	1,909 acres
Length of Shoreline	59.3 miles
Volume	606,730,687 cubic feet (MHW)
Mean Tidal Amplitude	8.6 feet
Salt Marsh Area	2,321 acres

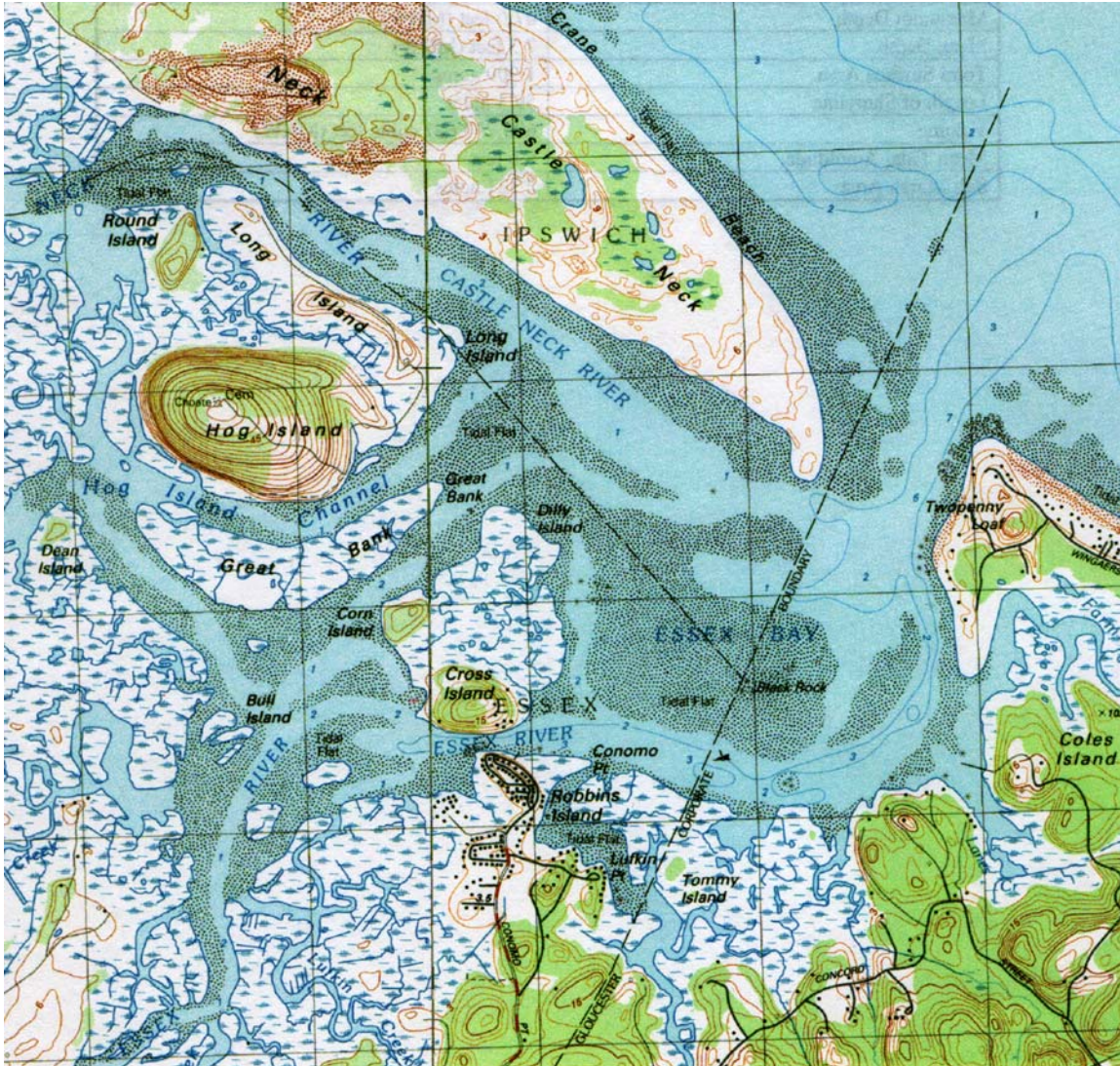


Figure 5. USGS map of Essex Bay

TIDAL FLATS

The Massachusetts Wetlands Protection Act defines tidal flats as “those nearly level portions of coastal beaches extending from mean low water landward to the more steeply sloping face of the beach” (Geist 1996). Tidal flats have substrate composed of materials ranging from very fine silt to clay and coarse sands and are found along the sea shore, in estuaries, behind barrier beaches, and in salt ponds. It is the combination of this salinity, substrate quality, and the character of water movement that determine plant and animal species composition in tidal flats. Large plants are not found on the flats because of the harsh sand-mud environment and daily tidal fluctuations. Instead, plants are mostly algae that tolerate exposure and do not need a physically stable surface for growing (Table 4) (Jerome et al. 1968). Although the importance of this plant life is often overlooked because it seldom provides a direct source of revenue, algae are vitally important to the marine environment in the ACEC because they provide food and cover for many forms of life such as snails, fish, and crustacea.

Table 4. Common algae in Plum Island Sound and Essex Bay (Jerome et al. 1968, Chesmore et al. 1973)	
Green Algae (Class Chlorophyceae) <i>Enteromorpha</i> spp. <i>Ulva lactuca</i> (sea lettuce)	Brown Algae (Class Phaeophyceae) <i>Ascophyllum nodosum</i> (rock weed) <i>Fucus vesiculosus</i> (rock weed) <i>Laminaria saccharina</i> (kelp) <i>Chorda filum</i> (devil’s whip)
Red Algae (Class Rhodophyceae) <i>Chondrus crispus</i> (Irish moss)	

Most of the animals found in tidal flats have also adapted to daily environmental stress or burrow beneath the exposed surface during low tide (Myers 1996) (Table 5). In addition to being habitat for many invertebrates, tidal flats are also a feeding area for large numbers of shorebirds that migrate through the region. Birds search the tidal flats for clams, snails, sand shrimp, amphipods, and worms that live just below the surface. At high tide, these same invertebrates are food for foraging fish, such as winter flounder and striped bass (Massachusetts Audubon Society 1999).

Table 5. Dominant organisms associated with different tidal habitats (Buchsbaum and Purinton 2000)	
Open water with sandy substrate	Atlantic silversides Mummichogs Sand shrimp
Muddy salt marsh habitats	Atlantic silversides Mummichogs Sand shrimp Shore shrimp
Brackish riverine habitats	White perch Smelt River herring White-fingered mud crab

SALT MARSH

Salt marshes are a predominant ecological and visual feature and make up over 50 percent of the Parker River/Essex Bay ACEC. With approximately 12,800 salt marsh acres, the ACEC contains the largest contiguous area of marsh north of Long Island, New York and is locally known as part of the “Great Marsh,” which runs from West Gloucester to Salisbury (Figure 6). ACEC salt marshes are well protected under the Massachusetts Wetlands Protection Act and through ownership or control by municipalities and conservation agencies and groups such as the U.S. Fish and Wildlife Service, Massachusetts Department of Fisheries and Wildlife, Essex County Greenbelt Association, and The Trustees of Reservations.

Salt marshes are a major source of nutrients for the marine food chain, provide flood control and protection of uplands from storm damage, and serve as efficient filters for contaminants from upland discharge and urban runoff. In addition, salt marshes provide habitat for diverse plants and wildlife (Table 6) (Jerome et al. 1968, Chesmore et al. 1973, Myers 1996).

“Many tidal creeks and salt pannes (shallow, temporary ponds on the marsh surface) are interspersed within the extensive open grassland of the marsh surface. These habitats are home to millions of small invertebrates that serve as food for salt marsh killifish and sticklebacks. These, in turn, are eaten by larger fish and birds. Small, upland islands within the marsh serve as resting and nesting areas for birds and animals that occasionally need some dry land” (Massachusetts Audubon Society 1999).

Table 6. Common salt marsh animals found in the ACEC (Buchsbaum et al. 1996)

Mollusks:	Coffee bean snail
Dragonflies:	Salt marsh skimmer
Grasshoppers:	Dusky-faced meadow grasshopper, salt meadow grasshopper
True flies:	Salt marsh mosquito, greenhead fly, chironomid midges, biting midges
Butterflies:	Broad winged skipper
Crustaceans:	Grass shrimp, isopod <i>Philoscia viltata</i> , several amphipod species
Fish:	Mummichog, nine-spined stickleback
Birds:	Clapper Rail, Willet, Wilson’s Phalarope, Seaside Sparrow, Salt Marsh Sharp-tailed sparrow

Marshes are divided into two general vegetation zones and contain a number of plant species that tolerate or live only in seawater (Table 7). The low marsh is flooded twice daily by the incoming tide and is dominated by *Spartina alterniflora*, while the high marsh is flooded sporadically and is dominated by *Spartina patens*.

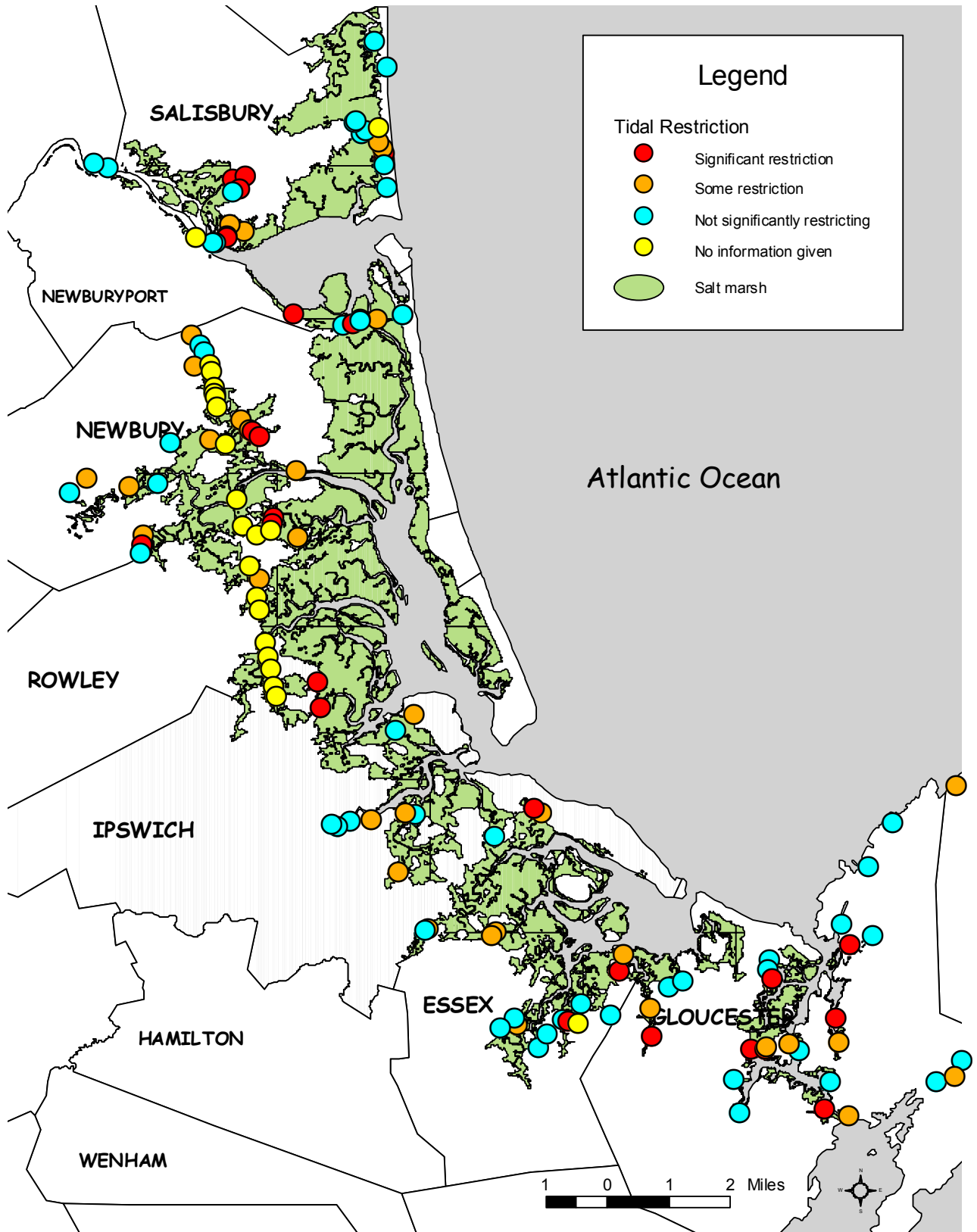


Figure 6. Great Marsh and ACEC salt marsh and tidal restriction sites

Table 7. Common salt marsh plants of the Parker River/Essex Bay ACEC
(Massachusetts Audubon Society 1999)

Shrubs	Other Nonwoody Plants and Wildflowers
Marsh elder (<i>Iva frutescens</i>)	Seaside goldenrod (<i>Solidago sempervirens</i>)
	Sea lavender (<i>Limonium carolinianum</i>)
Grasses, Sedges, and Rushes	Seaside pliantain (<i>Plantago oliganthos</i>)
Salt marsh cordgrass (<i>Spartina alterniflora</i>)	Sea milkwort (<i>Glaux maritima</i>)
Salt marsh hay (<i>Spartina patens</i>)	Marsh orach (<i>Atriplex patula</i>)
Common reed (<i>Phragmites australis</i>)	Glasswort (<i>Salicornia spp.</i>)
Spikegrass (<i>Distichlis spicata</i>)	Tall sea blite (<i>Suaeda lineraris</i>)
Black grass (<i>Juncus gerardi</i>)	Silverweed (<i>Potentilla anserina</i>)
Salt marsh bulrush (<i>Scirpus maritimus</i>)	Seaside arrowgrass (<i>Triglochin maritima</i>)
Salt marsh three square (<i>Scirpus robustus</i>)	Annual salt marsh aster (<i>Aster subulatus</i>)
Salt marsh sedge (<i>Carex hormathodes</i>)	Salt marsh water hemp (<i>Acnida cannabina</i>)

Historically, salt hay was used by early settlers for thatching roofs and cattle feed. From June to September, crews cut and stacked two types of hay: black grass growing at the highest points on the marsh was cut early in the season and hauled home by wagon; salt marsh hay or cordgrass growing on the lower marsh was stored on circles of posts called staddles and brought home during the winter months when the frozen marsh could safely bear the weight of the loaded sleds led by horses (Weare 1993). Since the 1960s, tractors pulling mechanical hay balers have been used to harvest salt hay. Only a few people still regularly hay to any extent in the ACEC marsh (Buchsbaum per comm 1999). Thus, the bulk of this marsh organic matter eventually contributes to the overall productivity of surrounding waters (Jerome et al. 1968). Studies on how haying affects the marsh ecosystem are currently underway by the Massachusetts Audubon Society and the Woods Hole Marine Biological Laboratory (MBL).

Although much of the salt marsh is still relatively pristine, there are concerns of human alterations and impacts to these habitats. For example, little is known about salt marsh alterations and impacts caused by mosquito ditching and tidal restrictions. Historically, much of the ACEC salt marsh was influenced by mosquito control activities, which can be seen from the extensive network of marsh ditches. Studies suggest that mosquito ditching reduces salt panne acreage and shorebird use of the marsh (Buchsbaum et al. 1996). Fortunately, current mosquito management practices through Open Marsh Water Management (OMWM) are more environmentally sensitive. OMWM is being used to restore marsh habitats by plugging old ditches in hopes of reducing drainage, maintaining and enhancing salt pannes, and channeling fresh water from uplands away from the salt marsh. Since OMWM incorporates existing ditches and natural features into their design, these practices have much less impact than past ditching activities (Buchsbaum and Purinton 2000).

Another major threat to salt marsh habitats of the ACEC is the invasion of the non-native plant *Phragmites australis*. Typically the invasive *Phragmites* grows where water is brackish at the edge or the transition zone of a salt marsh; growth might also be enhanced where higher nutrient levels from septic system leaching fields interact with groundwater tables. Occasionally, these plants will grow in the middle of the marsh where elevations are slightly higher or where there is a source of fresh water (Buchsbaum et al. 1996).

Phragmites encroachment into salt marsh habitats increases where tidal restrictions formed by the construction of roads, railroads, dikes, and tide gates impedes the natural flow of saline tidewater (Buchsbaum et al. 1996). Throughout the ACEC and Great Marsh, sites where the natural flow

of seawater is restricted by culverts or dikes were identified in a report by the Parker River Clean Water Association entitled *Tidal Crossings Inventory and Assessment* (PRCWA 1996) (Figure 6). As the vegetation changes and water flow is restricted, native plants are displaced, habitat is lost, and biodiversity decreases with a shift in species composition. *Phragmites* density was analyzed for the Plum Island Sound region as part of the Massachusetts Audubon Society's 1996 Minibay Project. Results of this study indicate that the invasive plant has not taken over a large percentage of the region so far, but it is widespread and occurs in stands ranging from a few plants to several acres (Buchsbaum et al. 1996). Since *Phragmites* is considered of less value to wildlife than native salt marsh species, these sites are being targeted by resource managers for restoration and monitoring efforts (Figure 7).

It is widely accepted that monitoring is an essential component of salt marsh management (Burdick et al. 1999). Monitoring is required to identify problems, modify management practices, track projects, evaluate success, help predict potential benefits, and increase our understanding of how salt marshes function. In June, 1998 the Massachusetts Audubon Society and the Gulf of Maine Council on the Marine Environment organized a meeting of managers, scientists, students, and policy makers at Castle Hill in Ipswich to discuss regional monitoring approaches, needs, and methods. A report compiled from meeting presentations and related studies is entitled, *Monitoring Restored and Created Salt Marshes in the Gulf of Maine* (1999). This report indicates that information gained by monitoring salt marsh restoration projects will "improve our understanding of salt marshes and their interactions with tidal waters and will benefit future marsh management programs" (Burdick et al. 1999).

Argilla Road in Ipswich is a tidally restricted restoration site where multiple parameters including vegetation, fish and crustacea, macroinvertebrates, salinity, and surface and groundwater hydrology are being monitored. In the fall of 1998, a unique collaboration of federal, state, and local officials, and conservation groups worked to restore approximately 20 acres of tidally restricted salt marsh at Argilla Road by replacing a 32" culvert with an 8' wide by 5' high box culvert. Tide gauges indicate that the previous restriction of 18" has improved to a 2.5-3" restriction. It also appears that much of the invasive *Phragmites* growth is stunted or dead with native *Salicornia* sprouting up underneath the stressed *Phragmites*. Large salt panne complexes have also been restored and are providing habitat for marsh fish (Hutchins et al. 1999). In addition to being a model for salt marsh monitoring throughout the region, this project provides an opportunity to educate the public about restoration and offers techniques to local communities wanting to sponsor similar projects (Catena 1998).

Two pro-active volunteer restoration programs managed by state agencies are also underway in the ACEC. The state Wetlands Restoration and Banking Program (WRBP) is working with volunteer professional scientists to monitor salt marsh restoration sites at Little Neck in Ipswich and Conomo Point in Essex. Over 60 scientists are part of this program which monitors vegetation, fish, macroinvertebrates, hydrology, and salinity both before and after restoration takes place. Citizen volunteers are also monitoring these two restoration sites through the Wetlands Health Assessment Toolbox (WHAT) program. CZM, the University of Massachusetts

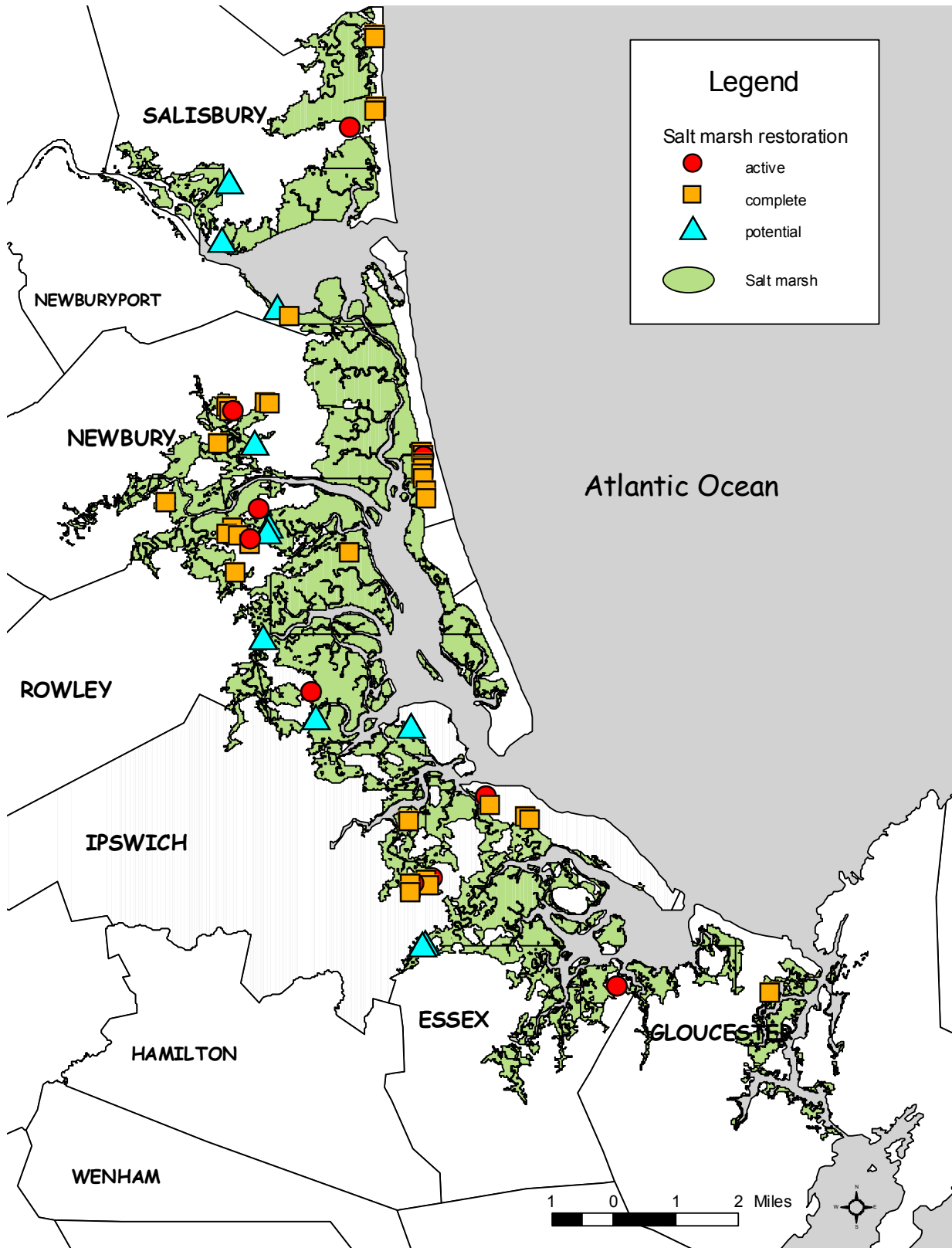


Figure 7. Great Marsh and ACEC salt marsh restoration sites

Cooperative Extension Program, and the Massachusetts Bays National Estuary Program have developed the WHAT approach to assessing wetland quality or ecological health through volunteer monitoring at four sites in the ACEC region. Each of the study sites, all having been adversely affected by tidal restrictions, stormwater discharges, and nonpoint source pollution from urban development, have a corresponding reference site that represented the best obtainable condition for the area. Parameters monitored at each site include: avifauna, vegetation, aquatic macroinvertebrates, water chemistry, tidal influence, and land use. Monitoring results indicate that shifts in plant and invertebrate community structure and indicator species richness and abundance are strongly associated with sources of nonpoint pollution and direct habitat impacts (Smith 1999). From data collected, CZM wetland specialists have developed a land use index which quantifies the degree and intensity of human land use within 100 meters of the salt marsh study site (Carlisle per comm 2000). By engaging citizens, WHAT partners hope to foster stewardship of wetlands and further educate communities about complicated issues surrounding wetland values and functions.

Salt Marsh Field Notes

The following responses are individual opinions rather than a consensus reached by those interviewed. Field note information can be used by local and regional resource managers to assess research needs, guide restoration efforts, prioritize future workplans, and design technical assistance programs.

The following people were interviewed about salt marsh resources:

Robert Buchsbaum	Massachusetts Audubon Society
Dave Burdick	University of New Hampshire
Wayne Castonguay	The Trustees of Reservations
Chuck Hopkinson	Woods Hole Marine Biological Laboratory
Chuck Katuska	Massachusetts Wetlands Restoration and Banking Program
Walter Montgomery	Northeast Massachusetts Mosquito Control and Wetlands Management
Tim Purinton	Massachusetts Audubon Society

1. Based on information gathered through existing research, have salt marsh habitats improved or declined in the past 20 years? Where is this trend going in the next 20 years?

- ◆ Assessment of the past 20 years greatly varies:
 - Although salt marshes have been protected through regulations since the 1970s, there have been significant impacts from tidal restrictions, disturbance of edge habitat, and increased stormwater inputs from development. Although tidal restrictions are being addressed throughout the region, impacts from invasive species and stormwater runoff have caused an overall decline in the acreage and function of marsh habitat in the past 20 years.
 - Overall, the ACEC salt marsh has remained relatively well protected and changes have been small over the last 20 years compared to similar ecosystems throughout the state.
 - There is not enough baseline historic monitoring to determine whether or not the marsh area and function has changed in the last 20 years.
- ◆ There is consensus that pressures on salt marsh resources will increase in the next 20 years:
 - Development on land surrounding the salt marsh will increase nonpoint source pollution, eutrophication, and invasive species, which will further degrade marsh transition zones.
 - Salt marsh habitat and function will decline from: 1) sea level rising more rapidly than natural salt marsh accretionary processes, and 2) human development on the upland marsh edge, which will prevent natural marsh transgression to inland areas.
 - Increased recreational boating will cause greater erosion and slumping of the salt marsh.
- ◆ Other views of future salt marsh trends include:
 - Salt marsh area and function will remain status quo as people's perceptions, appreciation, and respect improves with environmental education.
 - Marsh trends will depend on the economy...if economic growth continues, restoration project money will continue to be available for improving marsh habitat.

2. What additional research and monitoring is needed to improve our assessment of salt marsh habitats?

- ◆ All monitoring programs need to include, at a minimum, some indication of vegetation and hydrology with additional parameters of birds, fish, and biodiversity as needed on a project basis. The monitoring for each project should be scientifically rigorous, contain quantifiable measures of success, and be carried out over a sufficient period of time to provide meaningful results.

- ◆ Site specific monitoring is adequate, but a larger scale/systems approach is needed to monitor: 1) growth of invasive species, 2) erosion rates, 3) bank slumping, 4) nutrient loading, 5) impacts of mosquito pesticide (BTI) on the food web, and 6) potential long-term vegetation and habitat change as a result of sea-level rise.
- ◆ Long-term monitoring is needed to track vegetation change after restoration projects are complete.
- ◆ Fish and birds need to be sampled frequently to relate population change to restoration activities.
- ◆ Reference marshes that serve as controls for natural year to year variation need to be included in the design of a monitoring program.
- ◆ Academic involvement in salt marsh research needs to be strengthened. Currently, the Woods Hole Marine Biological Laboratory and the University of New Hampshire are the primary academic institutions doing comprehensive studies in the marsh. One way to increase academic research is to promote the salt marsh ecosystem as a site for graduate student studies.
- ◆ Although volunteers need supervision and clear monitoring goals, they are a valuable way to collect salt marsh restoration data.

3. What are threats or issues that need to be addressed in salt marsh habitats?

- ◆ Development and associated water quality problems around the marsh transition zone.
- ◆ Increased recreational boat use and issues of no wake zone enforcement, bank erosion and slumping, and jet ski impacts on tidal creeks.
- ◆ Tidal restrictions and impacts of invasive species growth, altered wildlife habitat, sedimentation, and elevation of the marsh.
- ◆ Sea level rise and associated shifts in vegetation.

4. What are opportunities for improvement or restoration of salt marsh habitats?

- ◆ Create a regional, salt marsh restoration site plan to help direct future actions and funding opportunities for restoration projects.
- ◆ Develop a clearinghouse of information learned from restoration activities that a variety of audiences can access when a new restoration project is started.
- ◆ Create a monitoring program for salt marsh sites that are actively and passively managed. Monitoring needs to be made a component of restoration grants and funding.
- ◆ Require the same monitoring protocols for mitigation projects as required of proactive restoration.
- ◆ Focus *Phragmites* management on control rather than elimination. Total elimination is not likely and perhaps not even desirable from a wildlife management perspective. The best way to control this invasive species is to eliminate tidal restrictions; the need to periodically repair bridges and culverts provides an opportunity to make incremental changes over time.
- ◆ Increase education and outreach about salt marsh resources, impacts, and benefits to a variety of targeted audiences...schools, business communities, local officials, etc. Existing restoration sites such as Argilla Road can be used for educational viewing.
- ◆ Improve coordination of restoration partners for permit review, enforcement, monitoring, and translation of monitoring results to local officials. The relationship between restoration partners and regulators can be improved by better articulating project expectations and outcomes.
- ◆ Promote using circuit riders to support restoration efforts and provide technical assistance.
- ◆ Improve enforcement and education of the “no wake zone” to reduce recreational boating impacts. Enforcement efforts can be implemented and improved by advocating for a full time harbor master and staff in each town while an educational brochure would increase the public’s awareness and understanding of this designated area.